Long-term aquaria study suggests species-specific responses of two cold-water corals to macro-and microplastics exposure

Vincent Mouchi, Leila Chapron, Erwan Peru, Audrey M Pruski, Anne-Leila Meistertzheim, Gilles Vétion, Pierre Galand, Franck Lartaud

Long-term aquaria study suggests species-specific responses of two cold-water corals to macro- and microplastics exposure

Vincent Mouchi[1*], Leila Chapron[1], Erwan Peru[1], Audrey M. Pruski[1], Anne-Leila Meistertzheim[2,3], Gilles Vétion[1], Pierre E. Galand[1], Franck Lartaud[1]

[1]: Sorbonne Université, CNRS, Laboratoire d'Ecogéochimie des Environnements Benthiques, LECOB, F-66650, Banyuls, France

[2]: Sorbonne Université, CNRS, Laboratoire d'Océanographie Microbienne, LOMIC, F-66650, Banyuls, France

[3]: Plastic@Sea, Laboratoire d'Océanographie Microbienne, LOMIC, F-66650, Banyuls, France

*: Corresponding author: vmouchi@gmail.com

ABSTRACT

Plastic pollution has been identified as a major threat for coastal marine life and ecosystems. Here, we test if the feeding behaviour and growth rate of the two most common cold-water coral species, *Lophelia pertusa* and *Madrepora oculata*, are affected by micro- or macroplastic exposures. Low-density polyethylene microplastics impair prey capture and growth rates of *L. pertusa* after five months of exposure. Macroplastic films, mimicking plastic bags trapped on deep-sea reefs, had however a limited impact on *L. pertusa* growth. This was due to an avoidance behaviour illustrated by the formation of skeletal 'caps' that changed the polyp orientation and allowed its access to food supply. On the contrary, *M. oculata* growth and feeding were not affected by plastic exposure. Such a species-specific response has the potential to induce a severe change in coral community composition and the associated biodiversity in deep-sea environments.

Growth and feeding behaviour are unchanged for *Madrepora oculata* when exposed to plastics. *Lophelia pertusa* is impacted by microplastics but acclimates to macroplastics.

KEYWORDS

Macroplastic litters, microplastics, cold-water corals, biomineralization, *Lophelia pertusa*, *Madrepora oculata*

INTRODUCTION

Anthropogenic activities have a strong negative impact on marine life as extensively documented for metal pollution (Islam and Tanaka, 2004), overfishing (Coll et al., 2008), trawling (Jones, 1992) or ocean acidification (Orr et al., 2005). Plastic pollutants have now been observed in all marine ecosystems (Bergmann et al., 2016; Herrera et al., 2019), including the deep-sea (Woodall et al., 2014). Macroplastics are large debris (> 5 mm of diameter) known to be harmful for marine life (Besseling et al., 2014; Derraik, 2002; Tanaka et al., 2013) and represent the "visible" part of the problem. Microplastics are small particles (< 5 mm; Arthur et al., 2009; GESAMP, 2015) that are formed by the progressive fragmentation of larger plastic debris or directly manufactured as small-size fragments (Rhodes, 2018). Plastic debris can also act as sorption surfaces for hydrophobic organic contaminants more efficiently than sediment particles (Teuten et al., 2007).

It has been suggested that animals feed on plastics because they look and smell like prey (Boerger et al., 2010; Fukuoka et al., 2016; Procter et al., 2019; Savoca et al., 2017). Numerous studies have attempted to estimate their impact on marine life (Cole et al., 2015; Hall et al., 2015; Lusher, 2015; Sussarellu et al., 2016) as their toxicity is of concern,

including for humans (Wright et al., 2013a). It has indeed been reported that drinking waters of 14 countries from five continents contain microplastic particles (Kosuth et al., 2018), although this assessment is debated (Koelmans et al., 2019). Microplastics can be ingested by zooplankton taxa and transferred to the food web (Setälä et al., 2014), and are also directly ingested by marine fishes (see Herrera et al. 2019 for a recent review), including the ones consumed by humans. Herrera et al. (2019) found for example microplastics in 78.4% of sampled mackerel fish sold on the Canary Islands. The impact of microplastics on health is challenging to assess from *in situ* observations, although some studies have found evidence of tropical corals being contaminated by toxic plastic chemical additives (such as phthalic acid esters; Saliu et al., 2019). Most studies use aquarium experiments and strong negative impacts have been highlighted in a variety of marine taxa (Sussarellu et al., 2016; Tang et al., 2018) including tropical (Hall et al., 2015; Reichert et al., 2018) and deep-sea corals (Chapron et al., 2018). This body of evidence suggests that microplastics represent an equivalent (if not greater) threat than macroplastics to marine communities.

As reef-builders in deep-sea environments, scleractinian cold-water corals (CWC) are of paramount importance for sea life as they provide a habitat to biodiversity hotspots compared to adjacent localities deprived of corals (Henry and Roberts, 2007). CWC, such as the colonial species *Lophelia pertusa* (now renamed *Desmophyllum pertusum*; Addamo et al., 2016) and *Madrepora oculata*, form a network of calcium carbonate skeletons consisting in branches of multiple corallites built by individual polyps. Macro- and microplastics have been reported in remote deep-sea coral provinces (La Beur et al., 2019) and macroplastic films have been observed to partially obstruct CWC reefs as they can be trapped in the corallite branches (Angiolillo et al., 2015). In short-term experiments (2.5 months), macroplastics were recently shown to impact the growth and prey capture rates, therefore, effecting colony health and survival of *L. pertusa* (Chapron et al., 2018). Those results, however, were restricted to one

76 species (i.e., *L. pertusa*) and no data is available for long-term exposure. Owing to the
77 difficulties in accessing deep-sea habitats, experiments on CWC are scarce, although it was
78 shown that these deep-sea organisms are exposed both to large plastic wastes and microplastic
79 debris (Taylor et al., 2016). Considering the crucial ecological role of CWC in deep-sea
80 ecosystems and the intensity of plastic pressures in these environments, it is important to
81 evaluate the impact of plastics on CWC in an attempt to forecast the expected changes on
82 coral ecosystems in future oceans.
83 In this study, we present the first investigation at long-term scale (five months) of macro- and
84 microplastic effects on two CWC species (*L. pertusa* and *M. oculata*).
85
86 MATERIALS AND METHODS
87 Origin of colonies
88 Corals used for this study were selected from *L. pertusa* and *M. oculata* colonies collected
89 live from the Lacaze-Duthiers Canyon, in the northwestern Mediterranean Sea (42°32'72"N,
90 03°25'28"E) at 540 m water depth in July 2012 by the Remotely Operated Vehicle (ROV)
91 Super Achille on the R/V Minibex (COMEX Company). Plastic debris have been observed in
92 this location over the years (Fiala-Medioni et al., 2012; Chapron et al., 2018). Sampled corals
93 were transferred onboard to aerated 30 L seawater tanks maintained at a constant temperature
94 of 13°C using a chiller. Once in the laboratory, corals were placed in a dark thermoregulated
95 room at 13°C ± 0.5°C in 80 L tanks receiving continuous flow of 5 µm-filtered Mediterranean
96 Sea water pumped from 5 m water depth. This setting allowed a renewal of over a full tank
97 per day. The colony fragments were each subdivided in nubbins of 3-5 polyps that were
98 subsequently secured on cement blocks using an aquatic epoxy resin (Lartaud et al., 2014). In
99 total, 34 *L. pertusa* and 70 *M. oculata* polyps (from one colony for each species) were used in
100 this study.

101

102 Experimental settings

103 *Aquaria settings*

104 The experimental design is similar to the one published earlier by Chapron et al. (2018). The
105 experiment consisted in three independent semi-closed flumes maintained in the dark at
106 13 °C ± 0.5 °C in a thermoregulated room (for microplastics, control and macroplastics
107 exposures; Fig. 1; Supplementary Fig. S1) of 58 L each (Purser et al., 2010). One renewal of
108 seawater per day was set up by a continuous supply of 2.5 L h^{-1} oxygenated, thermoregulated
109 (13°C) and filtered (5 µm) Mediterranean seawater to prevent contamination. A constant flow
110 of 2.5 cm s^{-1} was maintained by a motor (Modelcraft) driven propeller in each flume. A 180
111 µm mesh at the spillway retained microplastic particles within the tank. Corals were
112 acclimated for four weeks in the flumes before plastic addition. During the experiment, corals
113 were fed three times a week with freshly hatched (approx. 500 µm wide) *Artemia salina*
114 nauplii (350 individuals per litre) and once a week with Marine Snow plankton diet (Two
115 Little Fishes Inc, Miami Gardens, USA, 5 mL per flume).

116

117 *Plastic particles*

118 Macro- and microplastics were separately incubated for two months in 5 L seawater tanks
119 continuously supplied with filtered (20 µm) Mediterranean seawater in order to allow
120 bacterial colonization as observed in natural environments (Dussud et al., 2018a).
121 Microplastic beads of low-density polyethylene were added in one flume, with ovoid-shaped
122 beads of the same size (500 µm) and concentration (350 beads L^{-1}) than the ones of the
123 zooplankton used to feed the corals. This ratio of microplastic per zooplankton corresponds to
124 that observed in the Mediterranean surface waters, with concentrations ranging from 0 to 2.28
125 mg L^{-1} (Collignon et al., 2012; Pedrotti et al., 2016). The quantification of microplastics in the

126 deep-sea has not been reported so far, and measurements are limited by the mesh size of nets
127 used to recover particles (*e.g.*, 333 µm by Dussud et al., 2018b). Moreover, a recent study
128 suggests that the plastic particles content in the deep-sea is largely underestimated (Choy et
129 al., 2019). We therefore chose to use surface water values for the experiment as in Chapron et
130 al. (2018). Macroplastics were constituted of 10 x 10 cm polyethylene film, and added in
131 another flume, directly placed in contact of the cement blocks holding the corals in a way that
132 about 50% of the polyps were obstructed (Fig. 1) as observed in natural settings (Angiolillo et
133 al., 2015). The plastics were approximately 1 cm from the polyps.
134
135 Fig. 1. Experimental design and position of corals related to plastic exposure. The arrow
136 indicates the current direction.
137
138 Labelling and corallite growth measurements
139 At the start of the experiment, the specimens were labelled with fluorescent calcein at 150 mg
140 L^{-1} following the protocol described by Lartaud et al. (2013). The specimens were collected
141 after 5 months of plastic exposure and were cleaned in hydrogen peroxide (4%) at 60°C for 12
142 hours to remove all organic tissues. After embedding in ESCIL SODY 33 epoxy, specimens
143 were cut along the maximum growth axis of corallites using a Buehler Isomet low-speed saw.
144 Sections were polished using alumina down to 0.3 µm. Observations of calcein labels (Fig. 2)
145 were performed using an epifluorescence microscope Olympus BX UCB with an excitation at
146 495 nm (Excelitas X-Cite series 120Q). Distance between the label and the septa apex
147 (corresponding to the death of the coral) was measured (repeated 5 times) using the ImageJ
148 software (https://imagej.nih.gov/ij/) and considered as the polyp growth over the experiment
149 (Lartaud et al., 2013; Chapron et al., 2018).
150

Fig. 2. Observation of calcein label in a *L. pertusa* septa using an epifluorescence microscope. **a:** Orientation of cut along the maximum growth axis to expose septa of a *L. pertusa* specimen. **b:** Septa exposed once corallite was embedded in resin and cut. The rectangle area indicates the view on **c**. **c:** Fluorescence view of a septa showing the calcein labelling.

Prey capture rates

Coral prey capture rate was measured 92 and 136 days after the start of the experiment following a method described in Purser et al. (2010). Each hour, triplicate 100 mL water samples were collected after feeding. The water samples were filtered (55 µm mesh) and *A. salina* nauplii were counted to calculate the concentration of remaining *A. salina* in each flume. The number of zooplankton in each flume was normalized against the number of polyps in the flume, and that number was corrected for the macro- and microplastic flumes against the control flume. Following Purser et al. (2010) and Chapron et al. (2018), results presented focus on the first hour following prey delivery as corals consume over 65% of preys during this period.

Lipid analyses

Nubbins were immediately frozen in liquid nitrogen and stored at -80°C. Samples were then freeze-dried and ground to powder in liquid nitrogen with a TissueLyserII from QIAGEN. Total lipids were extracted from the freeze-dried polyps with chloroform: methanol (2:1) and assayed colorimetrically by the phosphosulfovanillic method (Barnes and Blastock, 1973) using a cholesterol standard. Lipid contents were expressed in mg of cholesterol equivalent and normalized per gram of polyp. Results are given in Supplementary Figure S2.

Statistical methods

Normal distribution for growth rates was checked by Kolmogorov-Smirnov tests on Matlab (v. R2017a). For each test, a normal distribution was rejected at 5% significance level. The *L. pertusa* and *M. oculata* populations (growth rates and capture rates) were tested separately to determine if their distributions were identical using Kruskal-Wallis tests at 5% significance level. Multiple comparison procedure by Tukey method was used to determine homogeneity between populations at 5% significance level.

RESULTS

Growth rates

No polyp mortality was observed for all conditions during the experiment. Overall, 76% of *L. pertusa* corallites and 66% of *M. oculata* corallites exhibited calcein labelling, so that the total number of fragments used for measurements and statistics was 26 and 46 for *L. pertusa* and *M. oculata*, respectively. The measured growth for all septa specimens presenting visible calcein labels are reported in Figure 3. Septal growth for *L. pertusa* was significantly lower in microplastics compared to control conditions (Tukey test, $p = 0.03$), with averages of 307 ± 360 µm and 1260 ± 770 µm respectively. *Lophelia pertusa* polyps exposed to microplastics also had significantly lower growth than polyps exposed to macroplastic conditions (Tukey test, $p = 0.02$), with a mean growth of 1890 ± 1670 µm for macroplastic conditions. *Lophelia pertusa* growth for macroplastics exposure were not statistically different from control settings (Tukey test, $p = 0.95$).

Fig. 3. Septa growth for *L. pertusa* (left) and *M. oculata* (right) exposed to micro- or macroplactics, or under control conditions at the end of the 5-months experiment. Mean, standard deviation and number of samples are shown. One outlier was observed for *M.*

200 *oculata* in control conditions (indicated by a '+' sign). The letters on top of the boxes indicate
201 significant differences between groups (Tukey tests).
202
203 Contrary to *L. pertusa*, *M. oculata* growth was similar between experimental conditions (Fig.
204 3). Although the mean septal growth was lower under microplastics exposure (152 ± 116 µm,
205 n=16) compared to that of macroplastics settings (189 ± 159 µm, n=15) and control (205 ±
206 198 µm, n=15), these values were not statistically different from one another (Kruskal-Wallis
207 test, $p = 0.93$).
208
209 Newly-formed growth structures
210 *Madrepora oculata* did not exhibit any growth abnormalities. However, all but one (86%) *L.*
211 *pertusa* polyps facing the macroplastic films (*i.e.*, with current obstruction) presented a partial
212 cover of the corallite, here called 'caps' (Fig. 4a). The polyp without this overgrowth presents
213 the lowest growth with only 27 µm longitudinal growth in 5 months. These 'cap' structures
214 were newly-formed as demonstrated by their position after the calcein labels (Fig. 4b). The
215 'caps' were thinner than the coral wall (~ 200 µm thick for caps compared to ~ 1 mm for coral
216 wall; Fig. 4c). Several millimetres of these 'caps' (3070 ± 1090 µm, n=4) were formed during
217 the experiment and were responsible for the highest values of the measured growth rates for
218 corals exposed to macroplastics (Fig. 3). When visible, calcein labels from the wall opposite
219 to that of the 'cap' initiation of these corallites are located at the edge of the septa, indicating
220 that these sides have not grown during the experiment (Fig. 4b and c).
221
222 Fig. 4. A newly-formed 'cap' (growth direction indicated by the red arrow) on *L. pertusa*
223 corallites facing the macroplastic (**a**). Septa are not concealed by the mineralisation of caps
224 (see septum indicated by the white arrow). Calcein label positioned on a scanning electron

microscope view (secondary electron mode, 15 kV) indicates that the 'caps' have been formed during the experiment (**b**). Organization of 'caps' on *L. pertusa* corallites relative to the walls in lateral section view (**c**) indicates that these structures, only present on approximately one-half of the corallite opening, are substantially thin compared to the wall.

Capture rates

Prey capture rates measured after three and five months of plastic exposure are reported in Figure 5. After three months, capture rates for *L. pertusa* exposed to microplastics were not statistically different from those of control specimens (Tukey test, $p = 0.50$; 278 ± 47 *A. salina* polyp^{-1} h^{-1} and 341 ± 26 *A. salina* polyp^{-1} h^{-1}, respectively). Polyps exposed to macroplastics also exhibited capture rates (462 ± 14 *A. salina* polyp^{-1} h^{-1}) similar to control specimens (Tukey test, $p = 0.50$), but they were higher than those of microplastic-exposed specimens (Tukey test, $p = 0.03$). After five months of exposure to microplastics, the capture rate of *L. pertusa* had decreased compared to control specimens (Tukey test, $p = 0.05$; 201 ± 44 *A. salina* polyp^{-1} h^{-1} and 480 ± 28 *A. salina* polyp^{-1} h^{-1}, respectively). For macroplastics, the capture rates (462 ± 28 *A. salina* polyp^{-1} h^{-1}) were not significantly different from those of control specimens (Tukey test, $p = 0.73$) but were significantly different from those of microplastic-exposed specimens (Tukey test, $p = 0.05$).

For *M. oculata*, the capture rates for corals exposed to both micro- (263 ± 135 *A. salina* polyp^{-1} h^{-1}) and macroplastics (267 ± 35 *A. salina* polyp^{-1} h^{-1}) were similar to control (269 ± 25 *A. salina* polyp^{-1} h^{-1}) after three months (Tukey test, $p = 0.90$ and $p = 1$, respectively) and five months (Tukey test, $p = 0.98$ and $p = 0.54$, respectively).

Fig. 5. Capture rates of *L. pertusa* (left) and *M. oculata* (right) after 3 months (top) and 5 months (bottom) of plastic exposure. Values are normalized against control specimens. Medians and quartiles are indicated.

DISCUSSION

The polyps of *L. pertusa* directly facing macroplastics, and thus more affected by this barrier limiting food supply, developed abnormal growth structures (here called caps) probably aiming at bypassing the plastic obstacle. The new production of caps, observed on all specimens facing the macroplastics, is likely a physiological response that forces the polyp to modify the orientation of its longitudinal growth. This avoidance behaviour will allow the coral to get around the obstacle and reach the nutrient flux again. This growth pattern changed the orientation of the elongation at the expense of wall thickness (Fig. 4c), generating potentially very fragile structures. The absence of growth on the side of the corallites opposite the cap can be explained by a temporary pause of mineralisation, which would resume once the cap is sufficiently strong to support the polyp. This is the first report of such avoidance behaviour at the polyp level. At colony levels, change of direction has been observed in natural settings (Roberts et al., 2009), although only after the full growth of the skeleton, and not at the initiation phase as we suspect happens here. It is also known that sessile taxa other than Scleractinia, such as bivalves, are able to change skeletal or shell growth direction to accommodate for terrain irregularity (Chinzei et al., 1982). This type of coral response to macroplastic exposure was not observed in Chapron et al. (2018) for experiments conducted at shorter timescales (2.5 months). Our results suggest that the cap generation observed here may provide *L. pertusa* successful response to plastic or other obstacles. High lipid contents in the nubbins of *L. pertusa* exposed to macroplastics confirm their good fitness (Supplementary Fig. S2) and suggest that the production of cap represents for the colony an

efficient strategy to overcome the obstructive effect of macroplastics or other obstacles. The reason why this response was however not observed for shorter exposure time (Chapron et al., 2018) is yet unknown.

Our study also reports a species-specific impact of plastic exposure for CWC for both micro- and macroplastics. While *L. pertusa* showed close similar patterns than those described in Chapron et al. (2018) *M. oculata* skeletal growth and capture rates were not impaired by microplastics exposure. One reason may be that *M. oculata* does not effectively capture the microplastics in the size range used in the experiment. *Madrepora oculata* could be selective in its diet and/or could display rejection behaviour for preys that have similar size to *Artemia* nauplii, which were used in our experiment. Indeed, it was observed that different taxa ingest different size of microplastic beads (van Cauwenberghe et al., 2015). This is supported by recent unpublished observations highlighting that *M. oculata* stores more energy when fed on phytoplankton rather than *Artemia* nauplii (Galand et al., submitted), and captures more effectively large *Artemia* (*i.e.*, 1000 µm) than nauplii (500 µm) (Surhoff et al., submitted). Inversely, it has been reported that *L. pertusa* is opportunistic in terms of diet, which ranges from phytodetritus (van Oevelen et al., 2009) to zooplankton (Freiwald, 2002; Kiriakoulakis et al., 2005) with prey size reaching 10 mm (Tsounis et al., 2010). If prey size selection is at play, *M. oculata* may exhibit equivalent negative impact than that observed on *L. pertusa* here when exposed to particles of different size than 500 µm.

The growth and capture rates of *M. oculata* were also unaffected by macroplastic exposure. *Madrepora oculata* polyps are smaller than those of *L. pertusa* (Lartaud et al., 2017). The macronutrient flux, although limited by the macroplastic obstacle, may be sufficient to provide the small polyps with food. Alternatively, the *M. oculata* polyps facing away from the obstacle could share their nutritional resources and/or energy with the other polyps in a more efficient way than does *L. pertusa*. Colonial organisms have been shown to share their

298 proteins between adjacent and sometimes remote polyps (Buss et al., 2015). However, *M.*
299 *oculata* polyps, contrary to *L. pertusa*, do not exhibit a physical link at the polyp basis, inside
300 the skeleton (Lartaud et al., *in press*), which opens additional questions regarding the
301 pathways of resource and energy sharing between polyps of a same branch or colony.
302 Species-specific vulnerability to plastic pollutants has previously been reported on tropical
303 coral species (Reichert et al., 2018). In their study, Reichert et al. (2018) showed that six coral
304 species exhibit different responses when exposed to microplastics for four weeks, such as
305 attachment to tentacles, mucus production, overgrowth and ingestion of microbeads. From the
306 six studied species, five exhibited negative health impacts, with the only species visibly not
307 impacted being *Porites lutea*, which was the only species using mucus production against the
308 exposure. In our study, mucus production was observed from both *L. pertusa* and *M. oculata*,
309 as it is often observed for cold-water coral species. This strategy seems ineffective for *L.*
310 *pertusa*.
311 After 5 months of exposure, *L. pertusa* exhibited significantly reduced growth rates when
312 exposed to microplastics. The energy balance plays a key role in the species' potential for
313 survival and acclimation to stress. In general, when conditions are optimal, energy is stored or
314 allocated for growth and reproduction, but reserves are depleted to withstand the additional
315 costs of stressful conditions (Lesser, 2013; Rossi and Tsounis, 2007). Therefore, our
316 measurements of lipids (Supplementary Fig. S2) indicate that control specimens presented
317 low energy reserves likely due to allocation to skeletal growth, while microplastic-exposed
318 polyps showed similar reserves without growth. Those results are in accordance with a short-
319 term (2.5 months) experiment showing a significant impact of plastics on growth of *L. pertusa*
320 (Chapron et al., 2018). The authors suggested a decrease of energy storage due to the
321 ingestion and egestion costs of microplastic beads. This is in agreement with observations
322 from shallow-water coral species that egested most of plastic particles within 24 to 48 h after

ingestion, but that energy supply (through consumption) and thus growth was expected to be reduced (Allen et al., 2017; Hankins et al., 2018). This reduction in capture rates has also been shown on the polychaete worm for which a chronic microplastic exposure inhibited feeding activity, which in turn reduced energy storage and organism fitness (growth rates and survival; Wright et al. 2013b). This could be due to a potential simulation of satiation or blockages of digestive cavities by microplastics as suggested in crustaceans and fishes (Cole et al., 2015; Critchell and Hoogenboom, 2018; Murray and Cowie, 2011; Watts et al., 2015). Interestingly, Chapron et al. (2018) reported that after 2.5 months of exposure capture rates reached those of the control specimens. Here, we also observed that capture rates in microplastic and control settings were not significantly different from each other after 3 months of exposure. However, an extended period of exposure to microplastics (5 months) had a significant negative impact on capture rate. A possible explanation is that *L. pertusa* compensates for microplastic exposure during several weeks but eventually fails to reach a sustainable state under this stress, hence dramatically reducing its feeding behaviour. Growth rate reaching normal values under microplastic exposure is therefore unlikely over a longer period (*i.e.*, over five months), and lingering negative impacts are to be expected.

CONCLUSION

This paper reports for the first time the effects of long-term micro- and macroplastic exposure on two cold-water coral species, *L. pertusa* and *M. oculata*. *Lophelia pertusa* was greatly affected by microplastic beads, both in terms of prey capture and growth rates. The impact of water current obstruction by macroplastic films appears limited as it was bypassed by polyp skeleton overgrows aiming at getting around the plastic obstacles. On the contrary, *M. oculata* was not impacted in either condition, as no difference was observed between control, micro- and macroplastic settings. We conclude that plastic pollution in nature, by impacting one

348 species more than another, could lead to a decrease in biodiversity in cold-water coral
349 ecosystems. Additional impacts on the associated fauna may also occur, as *L. pertusa* and *M.*
350 *oculata* are generally associated to improve the coherence of the carbonate reefs and protect
351 other taxa.
352
353 ACKNOWLEDGEMENTS
354 This work was funded by the RT2E-PLAISCOOL project (Fondation Rovaltain, coordination
355 F. Lartaud). Coral sampling was done as part of the research program of the Chair
356 'Biodiversity, extreme marine environment and global change' supported by Foundation
357 TOTAL, UPMC and CNRS, coord. N. Le Bris (LECOB). We thank the crew of the R/V
358 Minibex (COMEX) for their assistance in fieldwork and the facilities of Biology platform of
359 imaging and cytometry (BioPIC). Flume construction was funded by the Statoil funded
360 CORAMM project (coord. A. Purser).
361
362 REFERENCES
363 Addamo, A.M., Vertino, A., Stolarski, J., García-Jiménez, R., Taviani, M., Machordom, A.,
364 2016. Merging scleractinian genera: The overwhelming genetic similarity between
365 solitary *Desmophyllum* and colonial *Lophelia*. BMC Evol. Biol., 16, 108.
366 https://doi.org/10.1186/s12862-016-0654-8.
367 Allen, A.S., Seymour, A.C., Rittschof, D., 2017. Chemoreception drives plastic consumption
368 in a hard coral. Mar. Pollut. Bull., 124, 198-205.
369 https://doi.org/10.1016/j.marpolbul.2017.07.030.
370 Angiolillo, M., di Lorenzo, B., Farcomeni, A., Bo, M., Bavestrello, G., Santangelo, G., Cau,
371 A., Mastascusa, V., Cau, A., Sacco, F., Canese, S., 2015. Distribution and assessment of

372 marine debris in the deep Tyrrhenian Sea (NW Mediterranean Sea, Italy). Mar. Pollut.
373 Bull., 92, 149-159. https://doi.org/10.1016/j.marpolbul.2014.12.044.
374 Arthur, C., Baker, J., Bamford, H., 2009. Proceedings of the International Research Workshop
375 on the Occurrence, Effects and Fate of Microplastic Marine Debris. Group 530.
376 Barnes, H, Blackstock, J., 1973. Estimation of lipids in marine animals and tissues: detailed
377 investigation of the sulphophosphovanilun method for 'total' lipids. J. Exp. Mar. Biol.
378 Ecol., 12, 103-118. https://doi.org/10.1016/0022-0981(73)90040-3.
379 Besseling, E., Wang, B., Lürling, M., Koelmans, A.A., 2014. Nanoplastic affects growth of *S.*
380 *obliquus* and reproduction of *D. magna*. Environ. Sci. Technol., 48, 12336-12343.
381 https://doi.org/10.1021/es503001d.
382 Bergmann, M., Sandhop, N., Schewe, I., D'Hert, D., 2016. Observations of floating
383 anthropogenic litter in the Barents Sea and Fram Strait, Arctic. Polar Biol., 39, 553-560.
384 https://doi.org/10.1007/s00300-015-1795-8.
385 Boerger, C.M., Lattin, G.L., Moore, S.L., Moore, C.J., 2010. Plastic ingestion by
386 planktivorous fishes in the North Pacific Central Gyre. Mar. Pollut. Bull., 60, 2275-
387 2278. https://doi.org/10.1016/j.marpolbul.2010.08.007.
388 Buss, L.W., Anderson, C.P., Perry, E.K., Buss, E.D., Bolton, E.W., 2015. Nutrient
389 distribution and absorption in the colonial hydroid *Podocoryna carnea* is sequentially
390 diffusive and directional. PLoS One, 10, e0136814.
391 https://doi.org/10.1371/journal.pone.0136814.
392 Chapron, L., Peru, E., Engler, A., Ghiglione, J.F., Meistertzheim, A.L., Pruski, A.M., Purser,
393 A., Vétion, G., Galand, P.E., Lartaud, F., 2018. Macro- and microplastics affect cold-
394 water corals growth, feeding and behaviour. Sci. Rep., 8, 15299.
395 https://doi.org/10.1038/s41598-018-33683-6.

Chinzei, K., Savazzi, E., Seilacher, A., 1982. Adaptational strategies of bivalves living as infaunal secondary soft bottom dwellers. Neu. Jb. Geol. Paläont., 164, 229-244.

Choy, C.A., Robison, B.H., Gagne, T.O., Erwin, B., Firl, E., Halden, R.U., Hamilton, J.A., Katija, K., Lisin, S.E., Rolsky, C., Van Houtan, K.S., 2019. The vertical distribution and biological transport of marine microplastics across the epipelagic and mesopelagic water column. Sci. Rep., 9, 7843. https://doi.org/10.1038/s41598-019-44117-2.

Cole, M., Lindeque, P., Fileman, E., Halsband, C., Galloway, T.S., 2015. The impact of polystyrene microplastics on feeding, function and fecundity in the marine copepod *Calanus helgolandicus*. Environ. Sci. Technol., 49, 1130-1137. https://doi.org/10.1021/es504525u.

Coll, M., Libralato, S., Tudela, S., Palomera, I., Pranovi, F., 2008. Ecosystem overfishing in the ocean. PLoS One, 3, 12, e3881. doi:10.1371/journal.pone.0003881. https://doi.org/10.1371/journal.pone.0003881.

Collignon, A., Hecq, J.-H., Galgani, F., Voisin, P., Collard, F., Goffart, A., 2012. Neustonic microplastic and zooplankton in the North Western Mediterranean Sea. Mar. Pollut. Bull., 64, 861-864. https://doi.org/10.1016/j.marpolbul.2012.01.011.

Critchell, K., Hoogenboom, M.O., 2018. Effects of microplastic exposure on the body condition and behaviour of planktivorous reef fish (*Acanthochromis polyacanthus*). PLoS One, 13, 3, e0193308. https://doi.org/10.1371/journal.pone.0193308.

Derraik, J.G.B., 2002. The pollution of the marine environment by plastic debris: a review. Mar. Pollut. Bull., 44, 842-852. https://doi.org/10.1016/S0025-326X(02)00220-5.

Dussud, C., Hudec, C., George, M., Fabre, P., Higgs, P., Bruzaud, S., Delort, A.-M., Eyheraguibel, B., Meistertzheim, L., Jacquin, J., Cheng, J., Callac, N., Odobel, C., Rabouille, S., Ghiglione, J.-F., 2018a. Colonization of non-biodegradable and

biodegradable plastics by marine microorganisms. Front. Microbiol., 9, 1571. https://doi.org/10.3389/fmicb.2018.01571.

Dussud, C., Meistertzheim, A.L., Conan, P., Pujo-Pay, M., George, M., Fabre, P., Coudane, J., Higgs, P., Elineau, A., Pedrotti, M.L., Gorsky, G., Ghiglione, J.F., 2018b. Evidence of niche partitioning among bacteria living on plastics, organic particles and surrounding seawaters. Environ. Pollut., 236, 807-816. https://doi.org/10.1016/j.envpol.2017.12.027.

Fiala-Medioni, A., Madurell, T., Romans, P., Reyss, D., Pibot, A., Watremez, P., Ghiglione, M., Ferrari, B., Vuillemin, R., Lebaron, P., the scientific teams of the "Minibex" and "Medseacan" cruises (2008-2009), 2012. Rov and submersible surveys on faunal assemblages in a deep-sea canyon (rech Lacaze-Duthiers, western Mediterranean Sea). Vie Milieu, 62, 173–190.

Freiwald, A., 2002. Reef-forming cold-water corals. *In*: Wefer, G., Billett, D., Hebbeln, D. et al. (Eds), *Ocean Margin Systems*. Springer, Berlin; 365-385. https://doi.org/10.1007/978-3-662-05127-6_23.

Fukuoka, T., Yamane, M., Kinoshita, C., Narazaki, T., Marshall, G.J., Abernathy, K.J., Miyazaki, N., Sato, K., 2016. The feeding habit of sea turtles influences their reaction to artificial marine debris. Sci. Rep., 6, 28015. https://doi.org/10.1038/srep28015.

Galand, P., Remize, M., Meistertzheim, A.L., Pruski, A., Peru, E., Suhrhoo, T.J., Le Bris, N., Vétion, G., Lartaud, F., *in revision*. Diet shapes cold-water coral microbiomes. ISME J. *(in revision)*.

GESAMP, 2015. Sources, Fate and Effects of Microplastics in the Marine Environment: A Global Assessment". Technical Report. IMO/FAO/UNESCO-IOC/UNIDO/WMO/IAEA/UN/UNEP/UNDP Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection. 1020-

445 4873%5Cnhttp://ec.europa.eu/environment/marine/good-environmental-
446 status/descriptor-10/pdf/GESAMP_microplastics full study.pdf.
447 https://doi.org/10.13140/RG.2.1.3803.7925.
448 Hall, N.M., Berry, K.L.E., Rintoul, L., Hoogenboom, M.O., 2015. Microplastic ingestion by
449 scleractinian corals. Mar. Biol., 162, 725-732. https://doi.org/10.1007/s00227-015-
450 2619-7.
451 Hankins, C., Duffy, A., Drisco, K., 2018. Scleractinian coral microplastic ingestion: Potential
452 calcification effects, size limits, and retention. Mar. Pollut. Bull., 135, 587-593.
453 https://doi.org/10.1016/j.marpolbul.2018.07.067.
454 Henry, L.A., Roberts, J.M., 2007. Biodiversity and ecological composition of macrobenthos
455 on cold-water coral mounds and adjacent offmound habitat in the bathyal Porcupine
456 Seabight, NE Atlantic. Deep Sea Res. Part 1 Oceanogr. Res. Pap., 54, 654–672.
457 https://doi.org/10.1016/j.dsr.2007.01.005.
458 Herrera, A., Stindlova, A., Martinez, I., Rapp, J., Romero-Kutzner, V., Samper, M.D.,
459 Montoto, T., Aguiar-Gonzalez, B., Packard, T., Gomez, M., 2019. Microplastic
460 ingestion by Atlantic chub mackerel (*Scomber colias*) in the Canary Islands coast. Mar.
461 Pollut. Bull., 139, 127-135. https://doi.org/10.1016/j.marpolbul.2018.12.022.
462 Islam, M.S., Tanaka, M., 2004. Impacts of pollution on coastal and marine ecosystems
463 including coastal and marine fisheries and approach for management: a review and
464 synthesis. Mar. Pollut. Bull., 48, 624-649.
465 https://doi.org/10.1016/j.marpolbul.2003.12.004.
466 Jones, J.B., 1992. Environmental impact of trawling on the seabed: a review. N. Z. J. Mar.
467 Freshwater Res., 26, 59-67. https://doi.org/10.1080/00288330.1992.9516500.
468 Kiriakoulakis, K., Fisher, E., Wolff, G.A., Freiwald, A., Grehan, A., Roberts, J.M., 2005.
469 Lipids and nitrogen isotopes of two deep-water corals from the north-east Atlantic:

initial results and implications for their nutrition. *In*: Freiwald, A., Roberts, J.M. (Eds) *Cold-Water Corals and Ecosystems*. Springer, Berlin, 715-729. https://doi.org/10.1007/3-540-27673-4_37.

Koelmans, A.A., Nor, N.H.M., Hermsen, E., Kooi, M., Mintenig, S.M., De France, J., 2019. Microplastics in freshwaters and drinking water: Critical review and assessment of data quality. Water Res., 155, 410-422. https://doi.org/10.1016/j.watres.2019.02.054.

Kosuth, M., Mason, S.A., Wattenberg, E.V., 2018. Anthropogenic contamination of tap water, beer, and sea salt. PLoS One, 13, 4, e0194970. https://doi.org/10.1371/journal.pone.0194970.

La Beur, L., Henry, L.-A., Kazanidis, G., Hennige, S., McDonald, A., Shaver, M.P., Roberts, J.M., 2019. Baseline assessment of marine litter and microplastic ingestion by cold-water coral reef benthos at the East Mingulay marine protected area (Sea of the Hebrides, Western Scotland). Front. Mar. Sci., 6, 80. https://doi.org/10.3389/fmars.2019.00080.

Lartaud, F., Mouchi, V., Chapron, L., Meistertzheim, A.L., Le Bris, N., *in press*. Growth patterns of Mediterranean calcifying cold-water corals. *In*: Orejas, C., Jiménez, C. (Eds), *Past, present and future of Mediterranean Cold-water corals*, Springer.

Lartaud, F., Galli, G., Raza, A., Priori, C., Benedetti, M.C., Cau, A., Santangelo, G., Iannelli, M., Solidoro, C., Bramanti, L., 2017. Growth patterns in long-lived coral species. *In*: Rossi, S., Bramanti, L., Gori, A., Orejas, C. (Eds) *Marine animal forests*, Springer, Cham, 595-626. https://doi.org/10.1007/978-3-319-21012-4_15.

Lartaud, F., Pareige, S., de Rafélis, M., Feuillassier, L., Bideau, M., Peru, E., De la Vega, E., Nedoncelle, K., Romans, P., Le Bris, N., 2014. Temporal changes in the growth of two Mediterranean cold-water coral species, *in situ* and *in aquaria*. Deep Sea Res. Part 2 Top. Stud. Oceanogr., 99, 64-70. https://doi.org/10.1016/j.dsr2.2013.06.024.

Lartaud, F., Pareige, S., de Rafélis, M., Feuillassier, L., Bideau, M., Peru, E., Romans, P., Alcala, F., Le Bris, N., 2013. A new approach for assessing cold-water coral growth in situ using fluorescent calcein staining. Aquat. Living Resour., 26, 187-196. https://doi.org/10.1051/alr/2012029.

Lesser, M.P., 2013. Using energetic budgets to assess the effects of environmental stress on corals: are we measuring the right things? Coral Reefs, 32, 25-33. https://doi.org/10.1007/s00338-012-0993-x.

Lusher, A., 2015. Microplastics in the marine environment: distribution, interactions and effects. *In*: Bergmann, M., Gutow, L., Klages, M. (Eds.), *Marine Anthropogenic Litter*. Springer, New York, pp. 245–307. https://doi.org/10.1007/978-3-319-16510-3_10.

Murray, F., Cowie, P.R., 2011. Plastic contamination in the decapod crustacean *Nephrops norvegicus* (Linnaeus, 1758). Mar. Pollut. Bull., 62, 1207-1217. https://doi.org/10.1016/j.marpolbul.2011.03.032.

Orr, J.C., Fabry, V.J., Aumont, O., Bopp, L., Doney, S.C., Feely, R.A., Gnanadesikan, A., Fruber, N., Ishida, A., Joos, F., Key, R.M., Lindsay, K., Maier-Reimer, E., Matear, R., Monfray, P., Mouchet, A., Najjar, R.G., Plattner, G.-K., Rodgers, K.B., Sabine, C.L., Sarmiento, J.L., Schlitzer, R., Slater, R.D., Totterdel, I.J., Weirig, M.-F., Yamanaka, Y., Yool, A., 2005. Anthropogenic ocean acidification over the twenty-first century and its impact on calcifying organisms. Nature, 437, 681–686. doi:10.1038/nature04095.

Pedrotti, M.L., Petit, S., Elineau, A., Bruzaud, S., Crebassa, J.-C., Dumontet, B., Marti, E., Gorsky, G., Cozar, A., 2016. Changes in the floating plastic pollution of the Mediterranean Sea in relation to the distance to land. PLoS One, 11, e0161581. https://doi.org/10.1371/journal.pone.0161581.

518 Procter, J., Hopkins, F.E., Fileman, E.S., Lindeque, P.K., 2019. Smells good enough to eat:
519 Dimethyl sulphide (DMS) enhances copepod ingestion of microplastics. Mar. Pollut.
520 Bull., 138, 1-6. https://doi.org/10.1016/j.marpolbul.2018.11.014.
521 Purser, A., Larsson, A.I., Thomsen, L., van Oevelen, D., 2010. The influence of flow velocity
522 and food concentration on *Lophelia pertusa* (Scleractinia) zooplankton capture rates. J.
523 Exp. Mar. Biol. Ecol., 395, 55-62. https://doi.org/10.1016/j.jembe.2010.08.013.
524 Reichert, J., Schellenberg, J., Schubert, P., Wilke, T., 2018. Responses of reef building corals
525 to microplastic exposure. Environ. Pollut., 237, 955-960.
526 https://doi.org/10.1016/j.envpol.2017.11.006.
527 Rhodes, C.J., 2018. Plastic Pollution and Potential Solutions. Sci. Prog., 101, 207-260.
528 https://doi.org/10.3184/003685018X15294876706211.
529 Roberts, J.M., Wheeler, A.J., Freiwald, A., 2009. Cold water corals: the biology and geology
530 of deep-sea coral habitats. Cambridge University Press, Cambridge.
531 Rossi, S., Tsounis, G., 2007. Temporal and spatial variation in protein, carbohydrate, and lipid
532 levels in *Corallium rubrum* (Anthozoa, Octocorallia). Mar. Biol., 152, 429-439.
533 https://doi.org/10.1007/s00227-007-0702-4.
534 Saliu, F., Montano, S., Leoni, B., Lasagni, M., Galli, P., 2019. Microplastics as a threat to
535 coral reef environments: Detection of phthalate esters in neuston and scleractinian
536 corals from the Faafu Atoll, Maldives. Mar. Pollut. Bull., 142, 234-241.
537 https://doi.org/10.1016/j.marpolbul.2019.03.043.
538 Savoca, M.S., Tyson, C.W., McGill, M., Slager, C.J., 2017. Odours from marine plastic
539 debris induce food search behaviours in a forage fish. Proc. R. Soc. B, 284, 20171000.
540 http://dx.doi.org/10.1098/rspb.2017.1000.

Setälä, O., Fleming-Lehtinen, V., Lehtiniemi, M., 2014. Ingestion and transfer of microplastics in the planktonic food web. Environ. Pollut., 185, 77-83. https://doi.org/10.1016/j.envpol.2013.10.013.

Surhoff, T.J., Lartaud, F., Gerla, D., Peru, E., Thompsen, L., Le Bris, N., Purser, A., *in revision*. Lophelia pertusa and Madrepora oculata: the influence of prey size on achievable capture rates. Front. Mar. Sci. *(in revision)*.

Sussarellu, R., Suquet, M., Thomas, Y., Lambert, C., Fabioux, C., Pernet, M.E.J., Le Goïc, N., Quillien, V., Mingant, C., Epelboin, Y., Corporeau, C., Guyomarch, J., Robbens, J., Paul-Pont, I., Soudant, P., Huvet, A., 2016. Oyster reproduction is affected by exposure to polystyrene microplastics. Proc. Natl. Acad. Sci., 113, 2430-2435. https://doi.org/10.1073/pnas.1519019113.

Tanaka, K., Takada, H., Yamashita, R., Mizukawa, K., Fukuwaka, M.A., Watanuki, Y., 2013. Accumulation of plastic-derived chemicals in tissues of seabirds ingesting marine plastics. Mar. Pollut. Bull., 69, 219. doi:10.1016/j.marpolbul.2012.12.010.

Tang, J., Ni, X., Zhou, Z., Wang, L., Lin, S., 2018. Acute microplastic exposure raises stress response and suppresses detoxification and immune capacities in the scleractinian coral *Pocillopora damicornis*. Environ. Pollut., 243, 66-74. https://doi.org/10.1016/j.envpol.2018.08.045.

Taylor, M.L., Gwinnett, C., Robinson, L.F., Woodall, L.C., 2016. Plastic microfibre ingestion by deep-sea organisms. Sci. Rep., 6, 33997. https://doi.org/10.1038/srep33997.

Teuten, E.L., Rowland, S.J., Galloway, T.S., Thompson, R.C., 2007. Potential for plastics to transport hydrophobic contaminants. Environ. Sci. Technol., 41, 7759-7764. https://doi.org/10.1021/es071737s.

564 Tsounis, G., Ojeras, C., Reynaud, S., Gili, J.-M., Allemand, D., Ferrier-Pagès, C., 2010. Prey-
565 capture rates in four Mediterranean cold water corals. Mar. Ecol. Prog. Ser., 398, 149-
566 155. http://dx.doi.org/10.3354/meps08312.
567 van Cauwenberghe, L., Claessens, M., Vandegehuchte, M.B., Janssen, C.R., 2015.
568 Microplastics are taken up by mussels (*Mytilus edulis*) and lugworms (*Arenicola*
569 *marina*) living in natural habitats. Environ. Pollut., 199, 10-17.
570 https://doi.org/10.1016/j.envpol.2015.01.008.
571 van Oevelen, D., Duineveld, G., Lavaleye, M., Mienis, F., Soetaert, K., Heip, C.H.R., 2009.
572 The cold-water coral community as a hot spot for carbon cycling on continental
573 margins: a food-web analysis from Rockall Bank (northeast Atlantic). Limnol.
574 Oceanogr., 54, 1829-1844. https://doi.org/10.4319/lo.2009.54.6.1829.
575 Watts, A.J.R., Urbina, M.A., Corr, S., Lewis, C., Galloway, T.S., 2015. Ingestion of plastic
576 microfibers by the crab *Carcinus maenas* and its effect on food consumption and energy
577 balance. Environ. Sci. Technol., 49, 14597-14604.
578 https://doi.org/10.1021/acs.est.5b04026.
579 Woodall, I.C., Sanchez-Vidal, A., Canals, M., Paterson, G.L., Coppock, R., Sleight, V.,
580 Calafat, A., Rogers, A.D., Narayanaswamy, B.E., Thompson, R.C., 2014. The deep sea
581 is a major sink for microplastic debris. Royal Soc. Open Sci., 1, 4, 140371.
582 https://doi.org/10.1098/rsos.140317.
583 Wright, S.L., Thompson, R.C., Galloway, T.S., 2013a. The physical impacts of microplastics
584 on marine organisms: a review. Environ. Pollut., 178, 483-492.
585 https://doi.org/10.1016/j.envpol.2013.02.031.
586 Wright, S.L., Rowe, D., Thompson, R.C., Galloway, T.S., 2013b. Microplastic ingestion
587 decreases energy reserves in marine worms. Curr. Biol., 23, R1031–R1033.
588 https://doi.org/10.1016/j.cub.2013.10.068.

Figure captions:

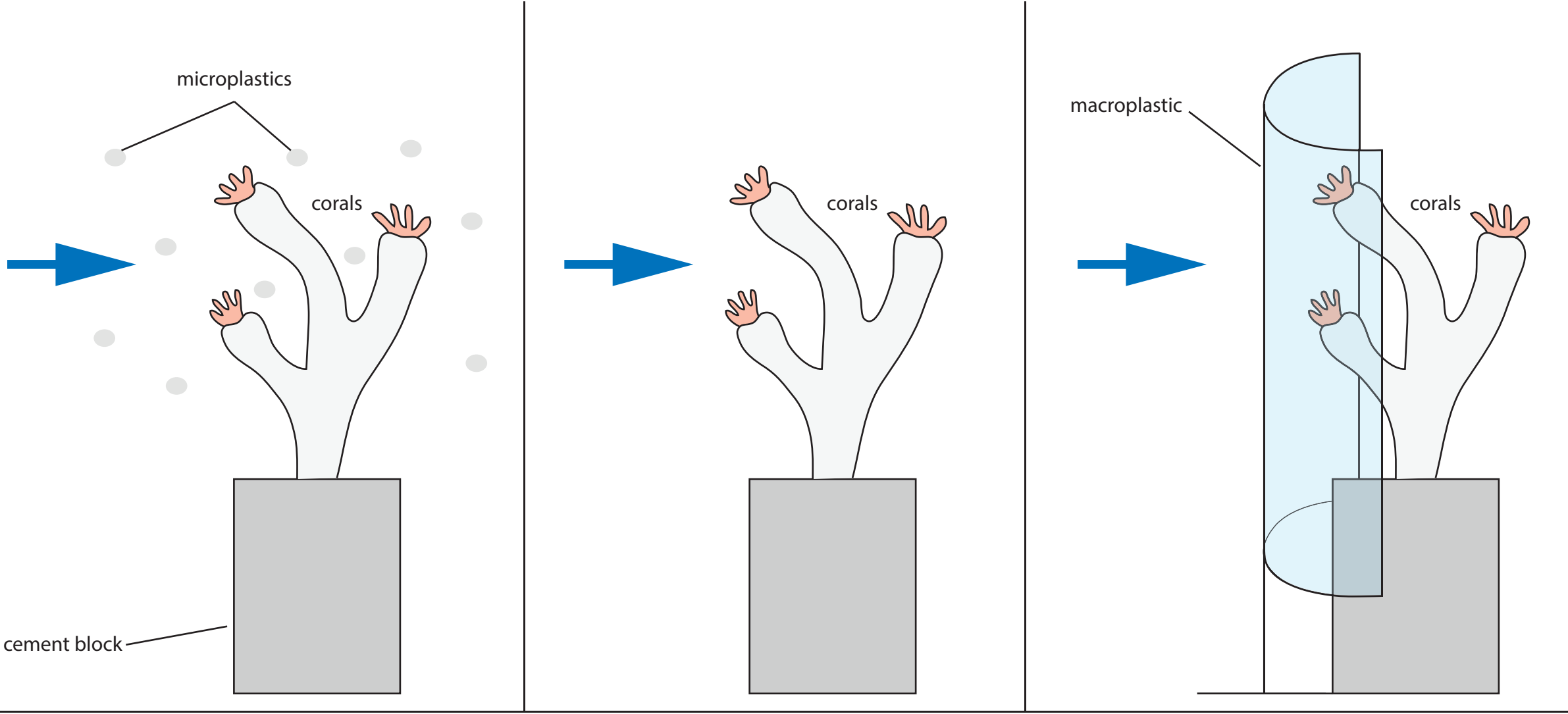
Fig. 1. Experimental design and position of corals related to plastic exposure. The arrow indicates the current direction.

Fig. 2. Observation of calcein label in a *L. pertusa* septa using an epifluorescence microscope. **a:** Orientation of cut along the maximum growth axis to expose septa of a *L. pertusa* specimen. **b:** Septa exposed once corallite was embedded in resin and cut. The rectangle area indicates the view on **c**. **c:** Fluorescence view of a septa showing the calcein labelling.

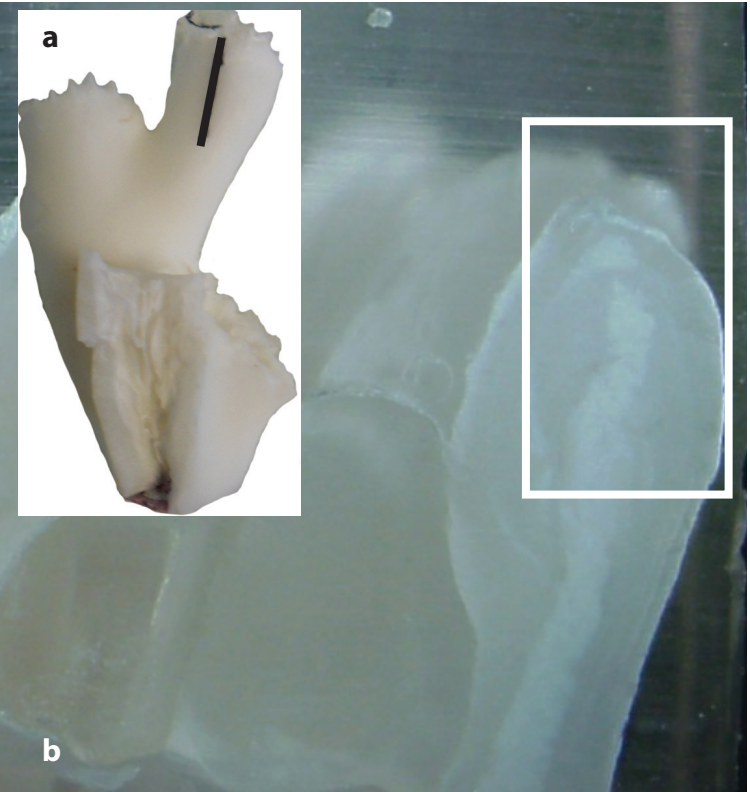
Fig. 3. Septa growth for *L. pertusa* (left) and *M. oculata* (right) exposed to micro- or macroplactics, or under control conditions at the end of the 5-months experiment. Mean, standard deviation and number of samples are shown. One outlier was observed for *M. oculata* in control conditions (indicated by a '+' sign). The letters on top of the boxes indicate significant differences between groups (Tukey tests).

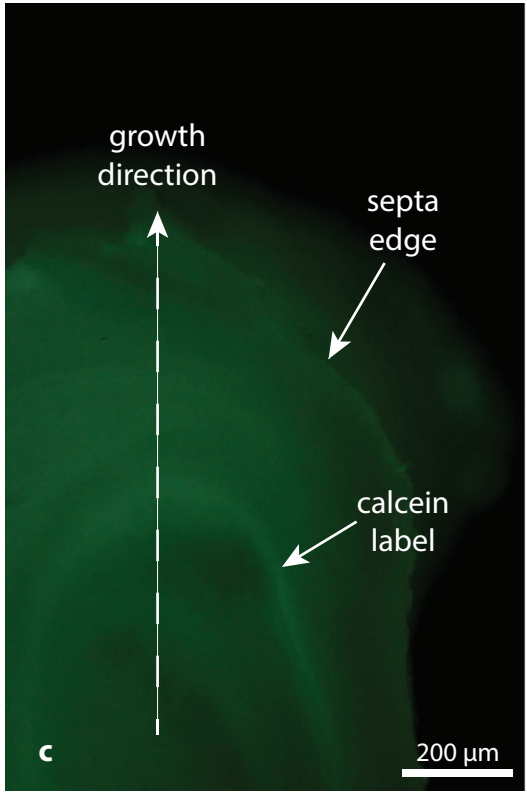
Fig. 4. A newly-formed 'cap' (growth direction indicated by the red arrow) on *L. pertusa* corallites facing the macroplastic (**a**). Septa are not concealed by the mineralisation of caps (see septum indicated by the white arrow). Calcein label positioned on a scanning electron microscope view (secondary electron mode, 15 kV) indicates that the 'caps' have been formed during the experiment (**b**). Organization of 'caps' on *L. pertusa* corallites relative to the walls in lateral section view (**c**) indicates that these structures, only present on approximately one-half of the corallite opening, are substantially thin compared to the wall.

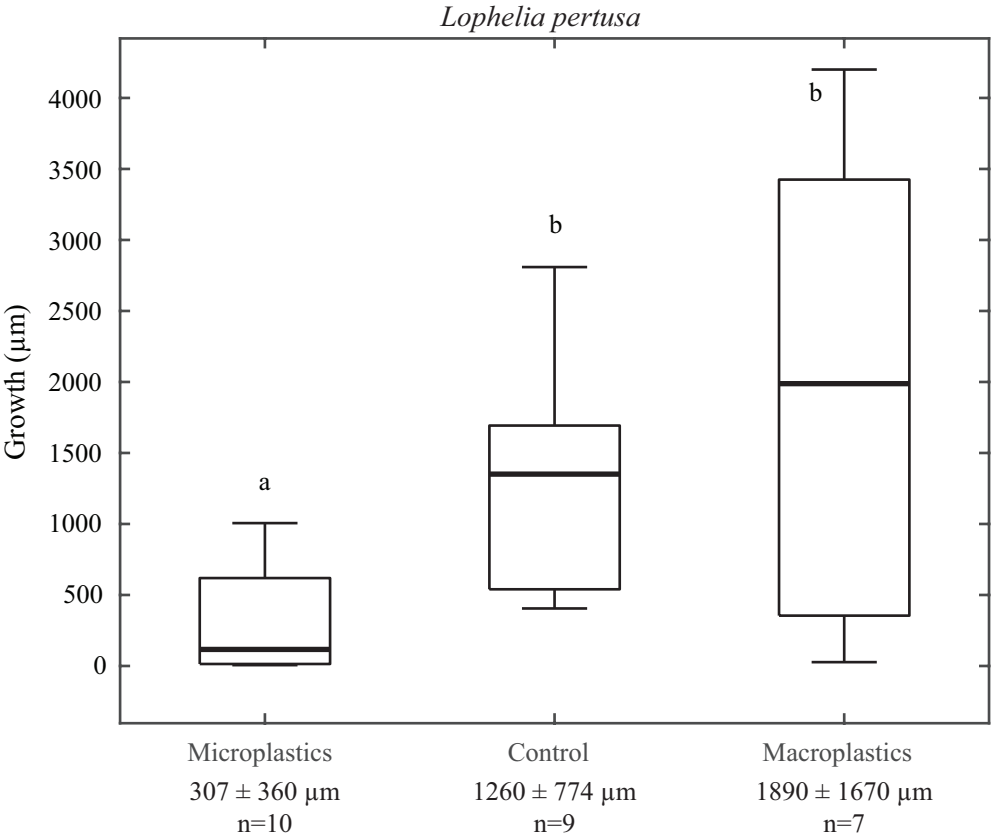
Fig. 5. Capture rates of *L. pertusa* (left) and *M. oculata* (right) after 3 months (top) and 5 months (bottom) of plastic exposure. Values are normalized against control specimens. Medians and quartiles are indicated.

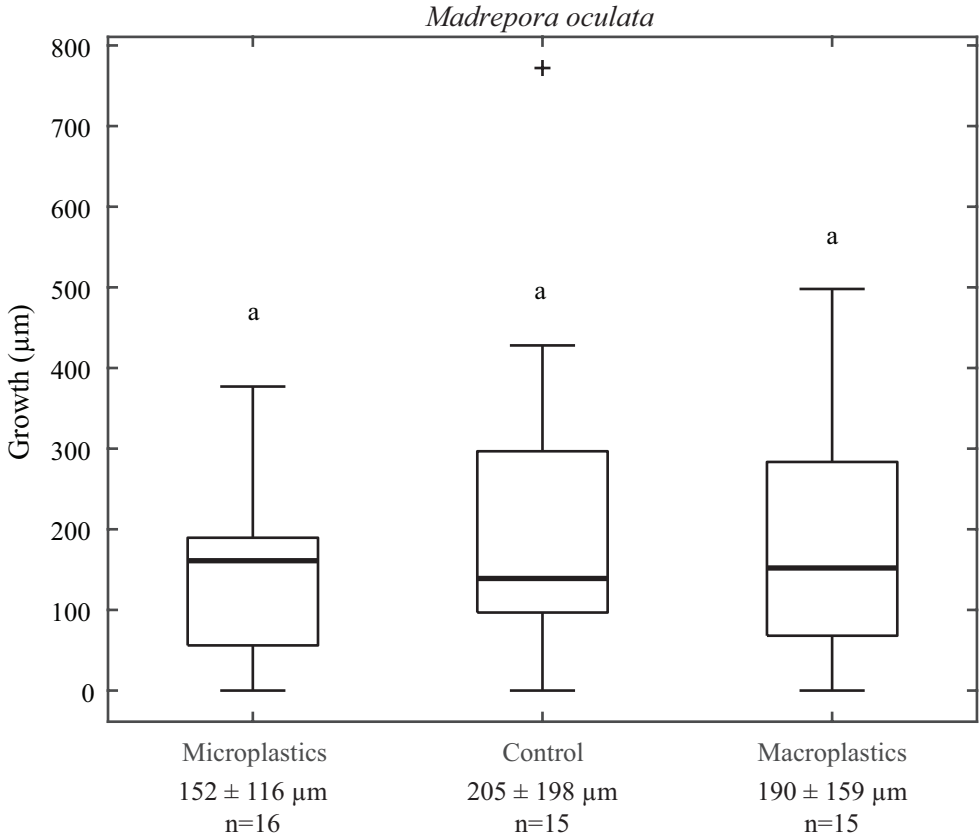


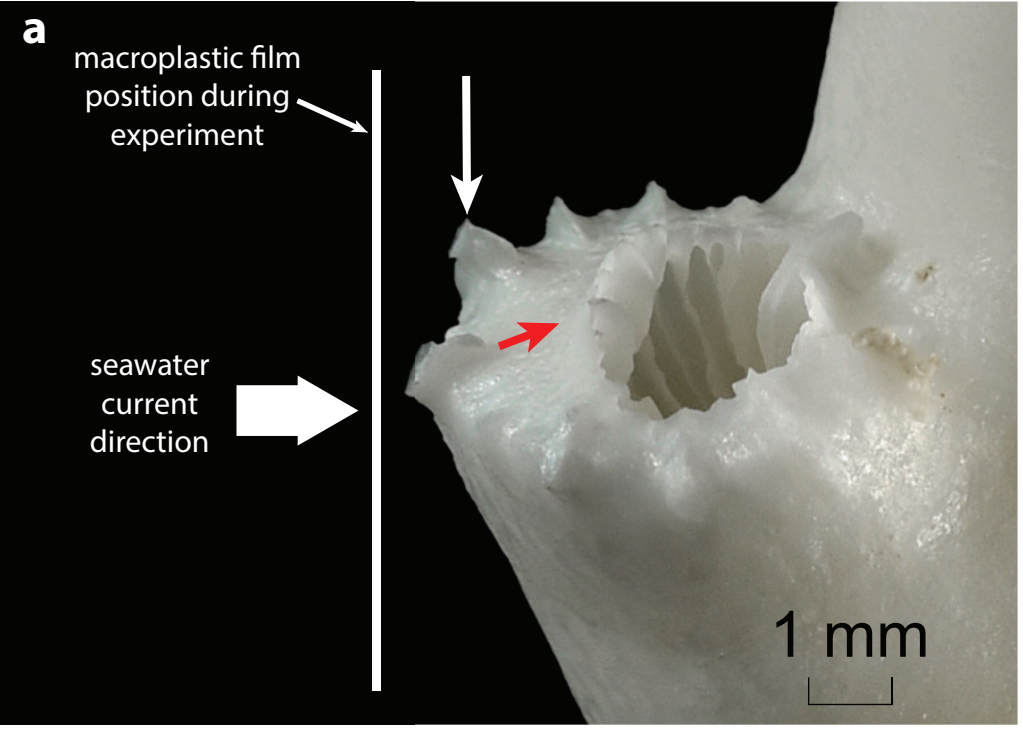
Microplastics settings **Control settings** **Macroplastics settings**

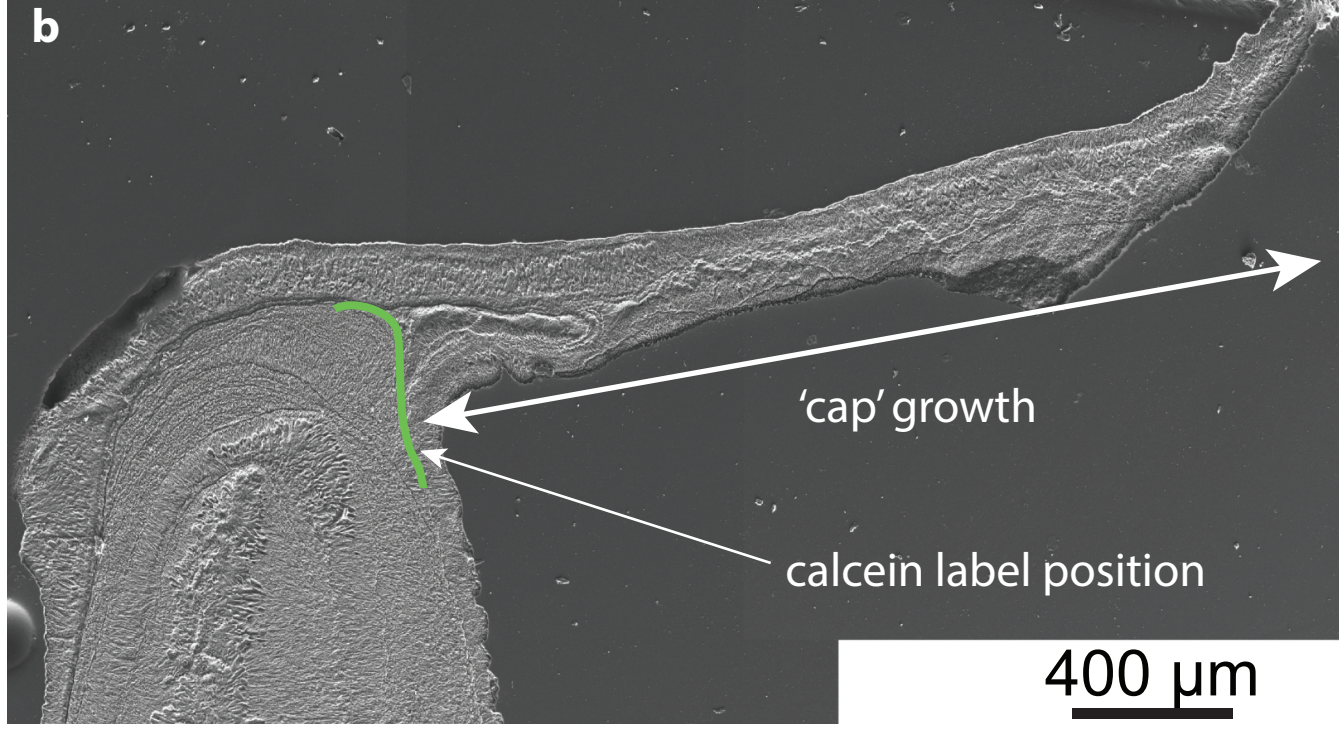

a
b

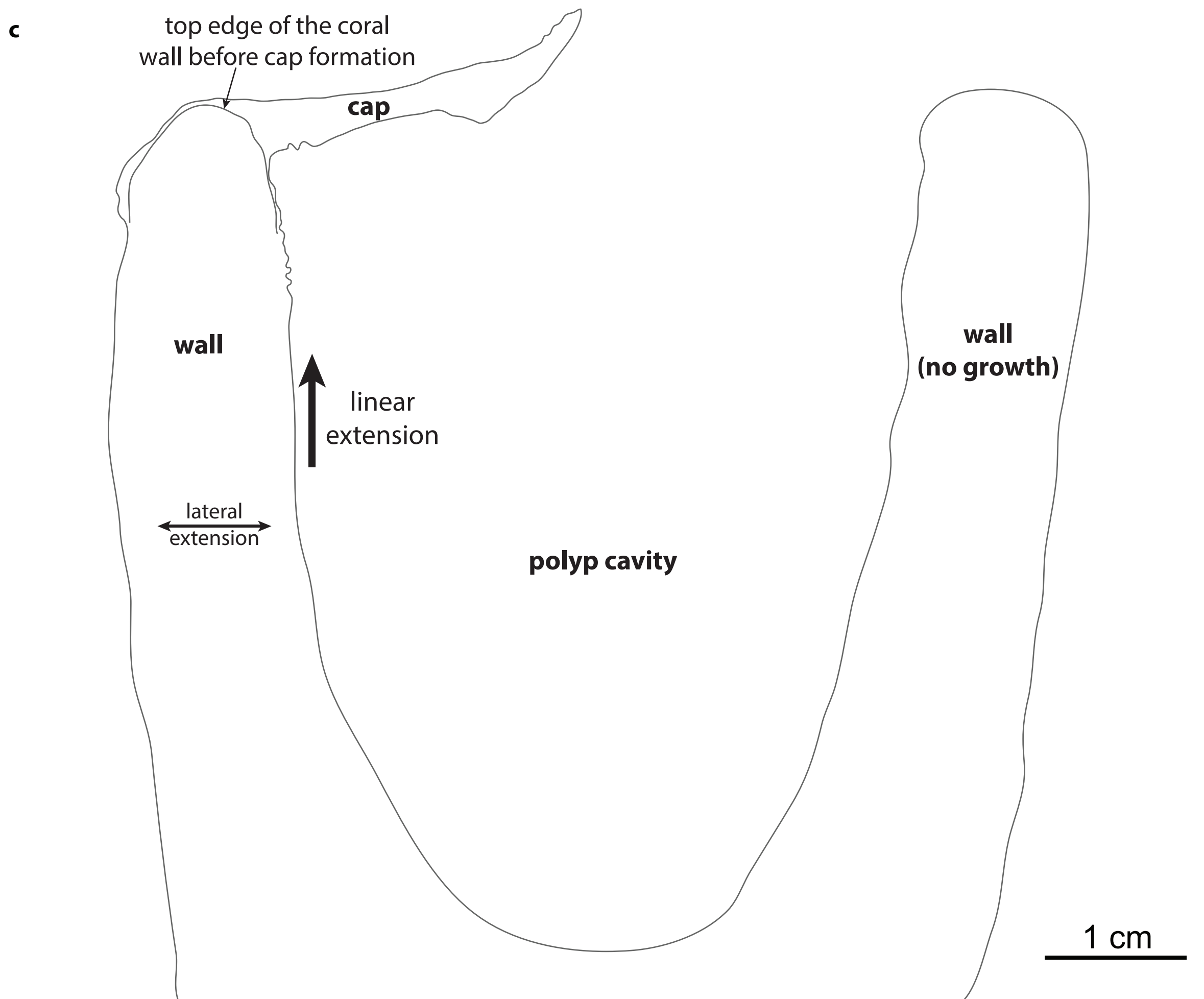

growth
direction
septa
edge
calcein
label
c
200 µm

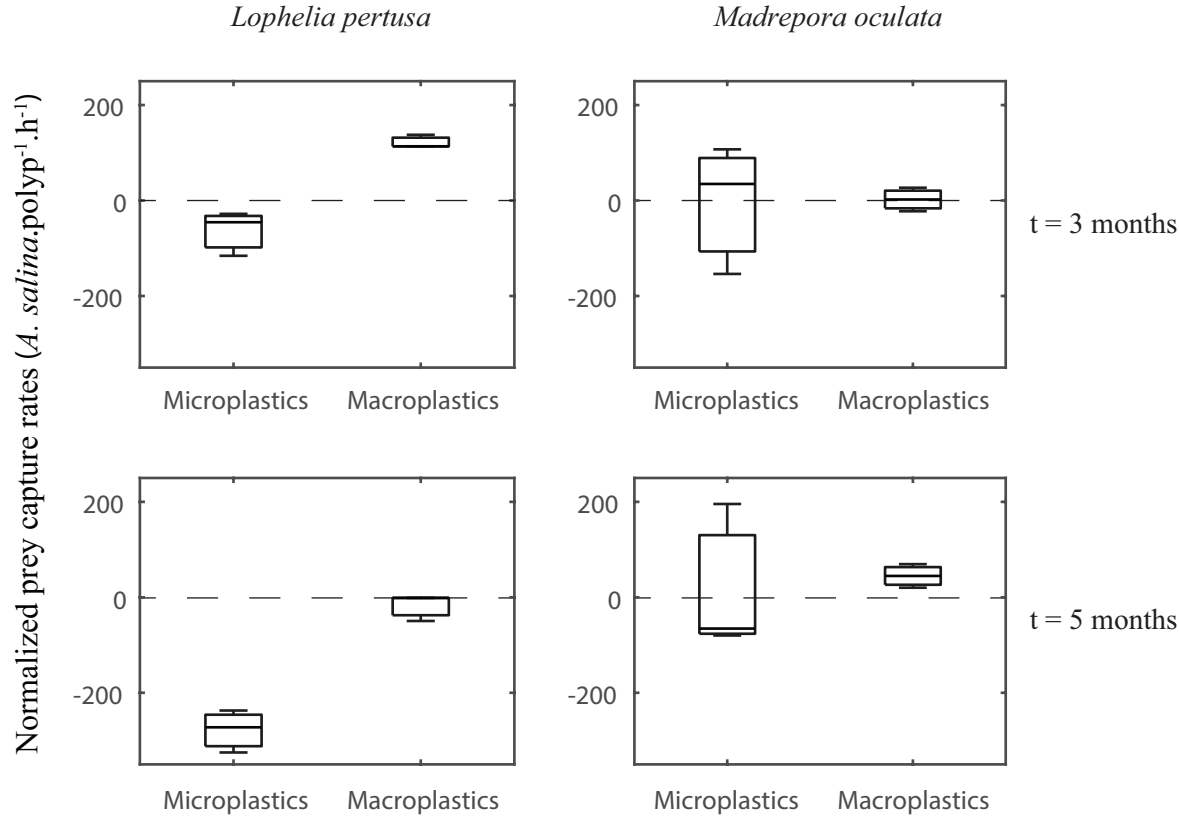

Lophelia pertusa
Growth (µm)
4000
3500
3000
2500
2000
1500
1000
500
0
a
b
b
Microplastics
307 ± 360 µm
n=10
Control
1260 ± 774 µm
n=9
Macroplastics
1890 ± 1670 µm
n=7


Madrepora oculata
Growth (µm)
800
700
600
500
400
300
200
100
0
a
a
a
Microplastics
152 ± 116 µm
n=16
Control
205 ± 198 µm
n=15
Macroplastics
190 ± 159 µm
n=15

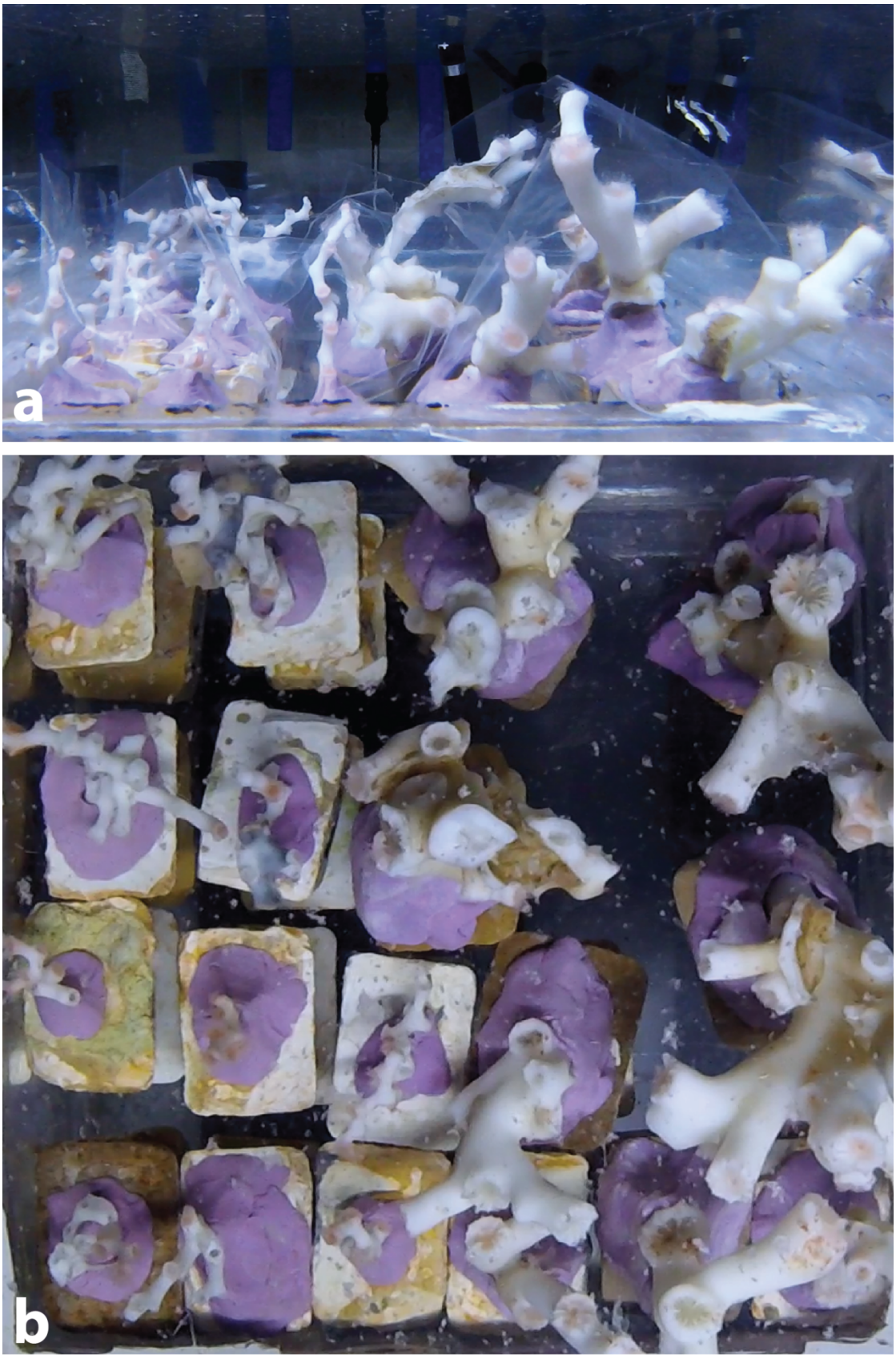

a
macroplastic film position during experiment
seawater current direction
1 mm


b
'cap' growth
calcein label position
400 µm


c
top edge of the coral wall before cap formation
cap
wall
linear extension
lateral extension
polyp cavity
wall (no growth)
1 cm

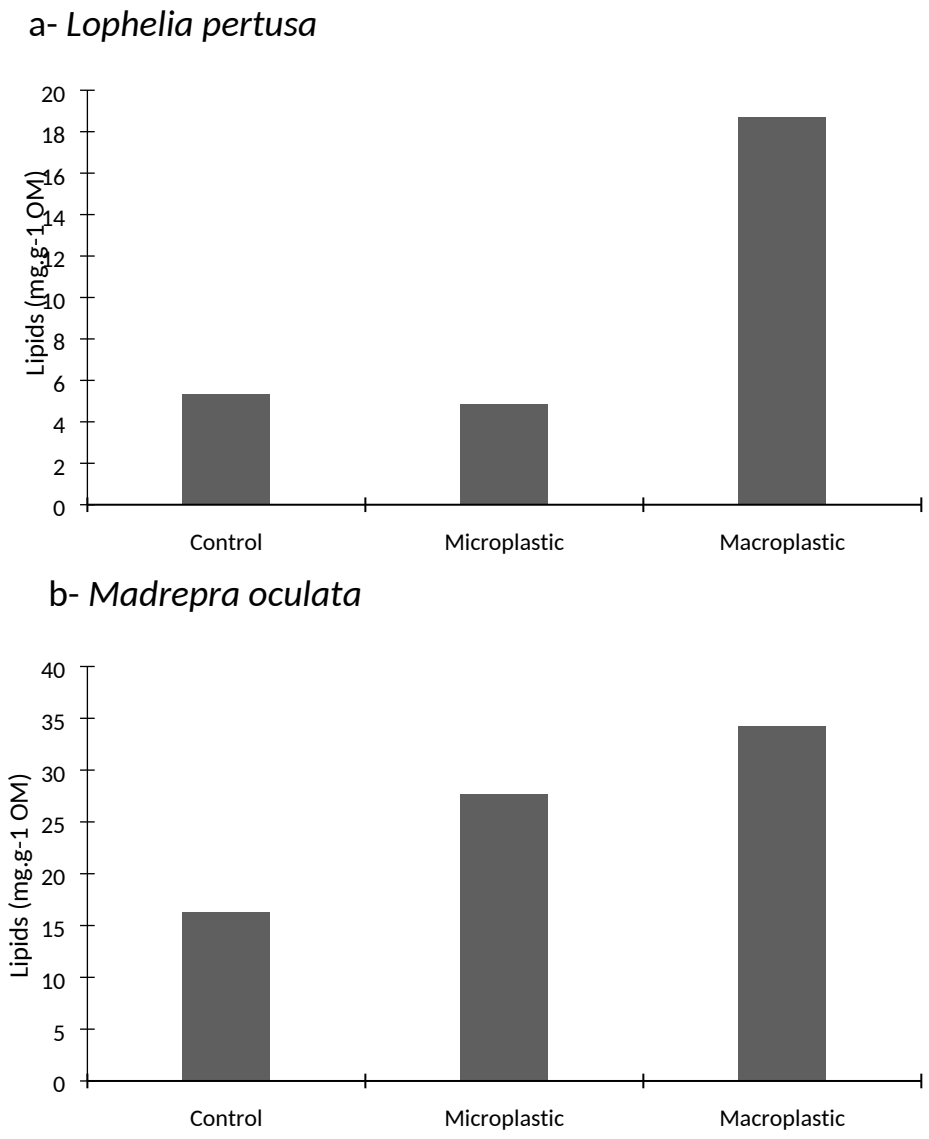

Lophelia pertusa
Madrepora oculata
Normalized prey capture rates (A. salina.polyp-1.h-1)
200
0
-200
Microplastics
Macroplastics
t = 3 months
t = 5 months

Supplementary Figure S1 of Mouchi et al.: “Long-term aquaria study suggests species-specific responses of two cold-water corals to macro- and microplastics exposure”.



Supplementary Fig. S1: Corals in aquaria with macroplastic films (a) and microplastic beads (b).

Supplementary Figure S2 of Mouchi et al.: “Long-term aquaria study suggests species-specific responses of two cold-water corals to macro- and microplastics exposure”.



Supplementary Figure S2: Lipid concentration in coral nubbies of *Lophelia pertusa* (a) and *Madrepora oculata* (b) after 5 months of exposure to control conditions, microplastics and macroplastics. Polyps from several nubbies were pooled for the analyses. Lipids are expressed in mg of equivalent cholesterol per gram of organic matter. The analytic error for the measure is less than 10%.